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The home installation in a multimedia cable network

Gerrit Boskaljon,
Tratec Telecom BV

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The home installation in a multimedia cable network

Gerrit Boskaljon of Tratec NV presents an overview of the Home Installation of a Multimedia Subscriber connected to a broadband cable network.

INTRODUCTION

In this article we present an overview of the Home Installation of a Multimedia Subscriber, connected to a broadband cable network. Besides the reception of standard analogue radio and TV channels, use is also made of interactive multimedia services.

This is an indication of the problems that may be anticipated with the equipment that a subscriber presents for use on the cable network. The influence on interactive services of a number of possible equipment arrangements is recorded. Many problems can be traced back to a single basic problem, the cause and solution of which is given.

Aim of the home installation

Before going into the technical aspects, first we shall define the aim of the home installation. The requirements that a good home installation must satisfy are set out in the following list.

1. *The home installation material must be quick and easy to install.*
2. *The home installation must make possible the connection of both a radio and TV plus VCR..*
3. *The home installation includes the possibility of connecting several multimedia applications such as Cable Modems, Set-Top Boxes and Pay TV Decoders etc.*
4. *The home installation must provide isolation of the network, equipment, people and animals from dangerous voltages.*
5. *The Home Installation must protect the Cable Network from subscriber ingress or interference.*
6. *The Home Installation must ensure that the equipment installed does not cause mutual interference.*

The first three requirements are, to a degree, clear and no further comment is needed.

Safety is an aspect that must not be neglected. Lightning strikes and mains voltages on the network cause annoying problems that, for the greater part, can be avoided by the use of the right equipment.

Screening of the cable TV Network against interference ingress from subscribers is the most important requirement. One subscriber can cause so much interference ingress that return path communication from a complete optical node can be disturbed. The result is possibly one hundred disappointed subscribers. However, this can be avoided with the right choice of equipment.

Mutual interference from Cable Modems to the TV and VCR is a regularly occurring problem, and can be prevented with proper isolation between connections..

Safety

In a good home installation, connection to the cable network is facilitated with the aid of a double galvanic isolated system outlet. 'Fully Isolated System Outlet' (FISO) is the official CENELEC term for a double galvanic isolated system outlet. In many instances there is in the home an earth-point at which the domestic electrical installation is grounded. In the Home Installation this is the preferred earth-point to which to connect the output side of the double Galvanic Isolated system outlet. Such a situation is shown in *Figure 1*.

If a home installation is not earthed, settling or balancing currents and leakage currents can occur. A balancing current is one that flows because of a potential difference between two points. The cable network is earthed and the subscriber's equipment is also earthed. Physics state that a large distance between two earth points can cause a potential difference between them. The balancing current is a DC current. Leakage currents are alternating currents that are set up, for instance, in the mains filter of a computer installation. The mains is filtered to remove transients, which are sunk to earth. Normally the earth connection is bonded to the chassis of the housing.

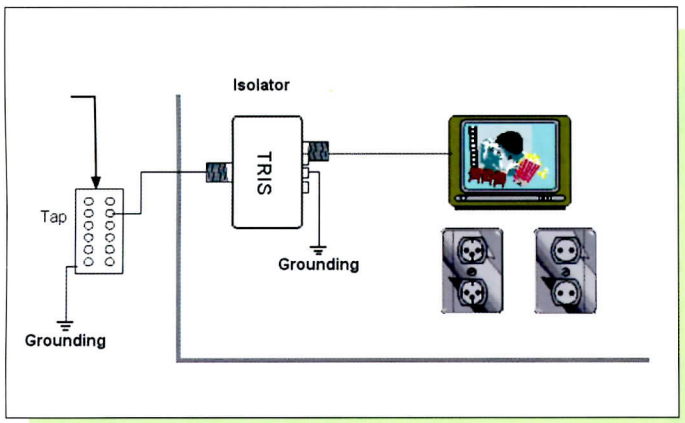

Figure 1 : Grounding of the home installation

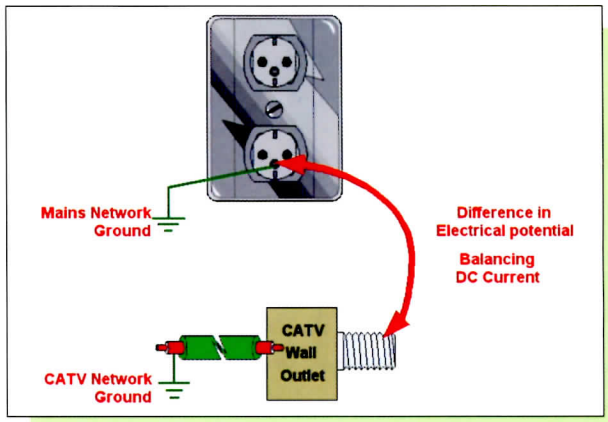

Figure 2 : Balancing current between two grounding points

The consequences of incorrect earthing

With a potential difference between the cable network and the subscriber's earth, in certain cases, a high difference voltage can be set up and damage to the computer or cable modem can occur. Also, corrosion from the flow of a balancing current is of concern. Leakage currents are alternating currents introducing hum modulation.

- *Earthed and non-earthed wall power sockets*

In the home we meet two types of wall power sockets for 230 V mains: Earthed and Non-Earthed.

- *Earthed wall power sockets*

In the situation where an earthed wall power socket is used in combination with a single galvanic isolated system outlet, a balancing current will be established whenever the connection between both grounding points is made.

In the cable TV network, the screening of the coaxial cable is earthed somewhere. It can be via the multitap, the drop amplifier or optical node.The supply mains earth is made directly in the home, often with an earth-rod.

The potential difference between these two points is responsible for the balancing current. See *Figure 2*.

The connection of a PC to a cable modem closes the electrical connection. The balancing current that flows now is DC and causes corrosion of the connections in the networks. With high potential differences, damage can result. See *Figure 3*.

- *Non-earthed wall power sockets*

With non-earthed power sockets, such as found in many instances in homes, the earth potential difference has no effect. Leakage currents, however, cannot flow to the mains supply earth and find alternative paths to ground via the cable network. See *Figure 4*.

Leakage current

Normally a personal (desktop) computer has a mains filter built into the power supply. This filter is built with coils and capacitors to stop spurious products and noise from the mains. Transients are fed to earth, provided the computer is equipped with a three-wire power cord connected to an earthed wall power socket. One side of the supply mains will cause a leakage current to flow via the decoupling capacitors, leaking away to earth or the chassis.

However, should the computer be connected to a non-earthed wall power socket this leakage current cannot flow to earth.

As soon as the chassis of the computer makes contact with a well-earthed point this leakage current will have found a path. The connection of a cable modem to the computer and the cable TV network makes a path for the leakage current to flow away via the cable TV network.

This leakage current is AC and introduces hum. Besides hum and corrosion problems, the voltage can also rise high enough to cause damage to the computer or the cable modem.

Lightning is a very common phenomenon. Strikes happen daily, frequently invading the cable TV network, the electricity supply network and at the subscriber installation. The lightning's energy is dissipated to earth by the route of least resistance. It can travel via the electricity supply mains and the subscriber's equipment to the cable network, or the other way round. There is a high probability that damage will occur.

Personal safety

The safety of the installer, as well as the customer, can be threatened by these potential differences. A second point is that the 230 V mains, through a defect in a piece of domestic equipment, can cause its chassis to become live. With a non-earthed power socket in use, mains potentials find their way to earth via the cable network. This places mains voltage on the cable TV network. Such situations are dangerous.

Solution

Where a double galvanic isolated system outlet is installed, no balancing current can arise. Make sure that the double galvanic isolated system outlet is earthed directly to the supply mains earth in the house. Through this connection any leakage current is led away directly to earth. Moreover, this is the preferred connection for a PC. Leakage currents are then conducted to the supply mains earth.

With a FISO the safety aspect is also satisfied. Live mains from a defective TV or PC on the home installation cannot reach the cable network because of the double galvanic isolated system outlet. A life threatening situation is averted because other subscribers and their equipment are

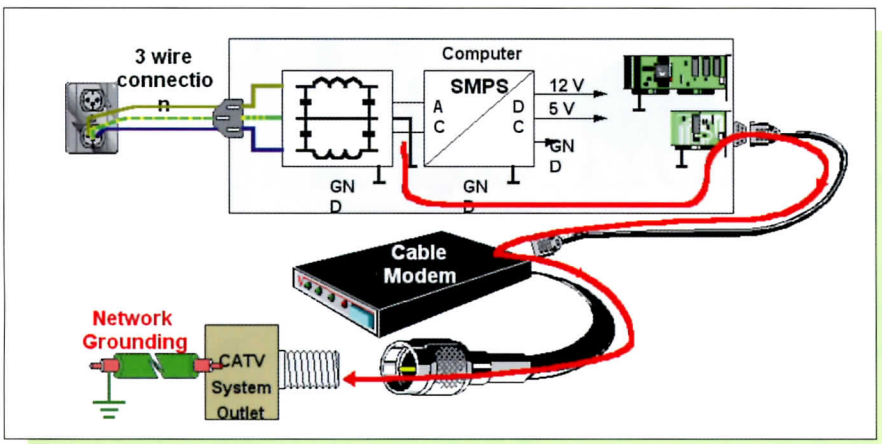

Figure 3 : Balancing current

effectively isolated. With lightning strikes, the double galvanic isolator presents an additional resistance barrier between the cable network and the home installation.

Screening from subscriber ingress

In an average family there are at least two television sets, a video recorder and a radio present. One radio, a TV and VCR in the living room and one TV in a bedroom or children's room. The cable operator supplies a master system outlet in the home for access to the network. From this, the subscriber has to fit a splitter to provide a second outlet. The material for this, often of an indifferent quality, comes in most cases from a DIY (Do-It-Yourself) supplier. DIY coax cable frequently has a screening factor of less than 30dB. Murphy's Law suggests that, of the two connections required, that for the TV will be placed in the opposite corner of the room to the system outlet!

The connection, of an inferior DIY splitter and two times ten metres of DIY coaxial cable have, besides the intended function of delivering signals a second unwanted quality: it is a good dipole antenna for short-wave signals and other disturbances from the ether. These are, in fact, received and injected directly into the cable network return path.

Alongside these cables are store-bought connection cables furnished with plastic IEC connectors, usually having poor screening with consequeny problems.

Equipment and sources of ingress at the subscriber

Equipments connected by the subscriber such as a Radio, VCR or TV set can themselves cause ingress problems, particularly older generation apparatus. The rejection of IF signals to the antenna input of the TV is not always satisfactory. At the antenna input, therefore, there is a small signal at 38.9 MHz. Without precautionary measures, the signal will find its way into the cable network.

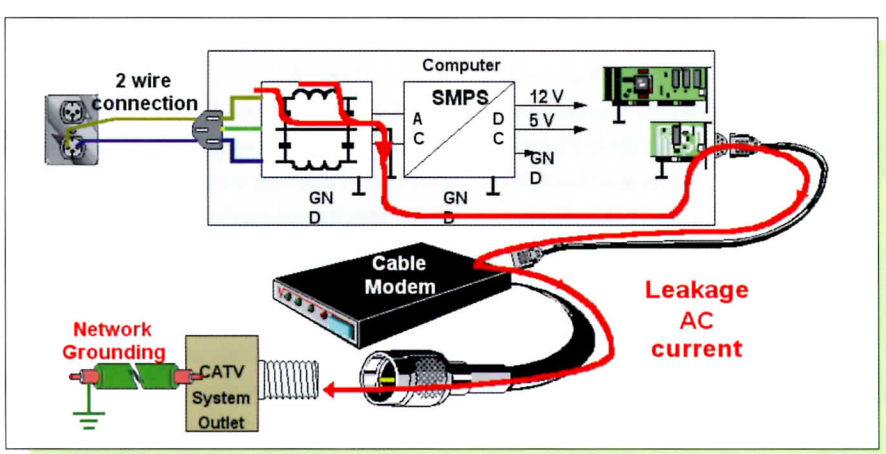

Figure 4 : Leakage current

Effect on the return path

It is true that the IF signal from a TV is small, but there are many TV sets connected. Let us consider an optical node with 1000 dwellings connected and, on average, two TV sets per dwelling of which 70 percent are operating simultaneously. 50 percent of these are older models, so that 350 sets are producing a 38.9MHz signal. These IF signals are at the same frequency. However, the signals are not in phase. So for our calculation we can not use the voltage addition (20log n). In practice the value lies between 14 and 17 Log n. (n = number of sources). With 350 sets it is apparent that the sum of all IF signals is from 14 Log 350 = 35.6dB up to 17 Log 350 = 43.25dB up on the basic. An IF level of 5dBμV at the antenna input can cause a total ingress product at the optical node of between 40 and 48dBμV.

Remaining ingress sources at the subscriber

Wireless telephones, not GSM or DECT apparatus but the first generation models (CT0), often work on frequencies around 30MHz. Communication ranges of these wireless telephones are from 300 metres to sometimes beyond 1,000 metres. The RF output power is often 100mW or more. The result of combining a 100mW transmitter with DIY coax cable is a telephone signal in the return path. Another, similar, source of trouble is the baby listening device transmitting directly via the cable into the return path of the cable network.

Also there is the radio amateur and particularly those on the 27MHz band. The high transmission power levels in use increase the effects of ingress. Short-Wave radio signals are also, naturally, picked up by the poorly-screened coax. With these lower frequencies we can assume that signals within a group of subscribers are almost in phase and that the summation of these delivers a higher figure. The levels of

these signals can vary in strength dependent upon the conditions, the ionosphere can absorb or reflect them and daytime to night-time differences play their part.

Household Appliances

Modern households contain many domestic aids. With the microwave oven we can include the vacuum cleaner and a plethora of kitchen equipment. Ownership of these devices is widespread, most of them containing a motor. Many such motors are of the carbon brush and armature type which give rise to sparking. If we dig deeply into memory we still remember Marconi well. This man is responsible for our present-day livelihood through the discovery of the spark transmitter. Though the spark transmitter has been superseded in favour of more hi-tech solutions, it survives in the bodies of many household appliances.

Summarising, we can suppose that poor cabling in the home installation is the cause of many ingress problems.

Because it is not feasible in al cases to replace the cable, we must take precautions in the home network installation to ensure that RF pick-up in the return path band will not occur. These cabling problems will, in the future, grow worse with the arrival of DVB-T. This system delivers field strengths of 90dBμV/m and more. Investigations make it clear that with DIY cabling in home installations, all disturbances appear at a field strength of 70dBμV/m. Especially with DVB-T channels on the same frequencies as the cable TV channels.

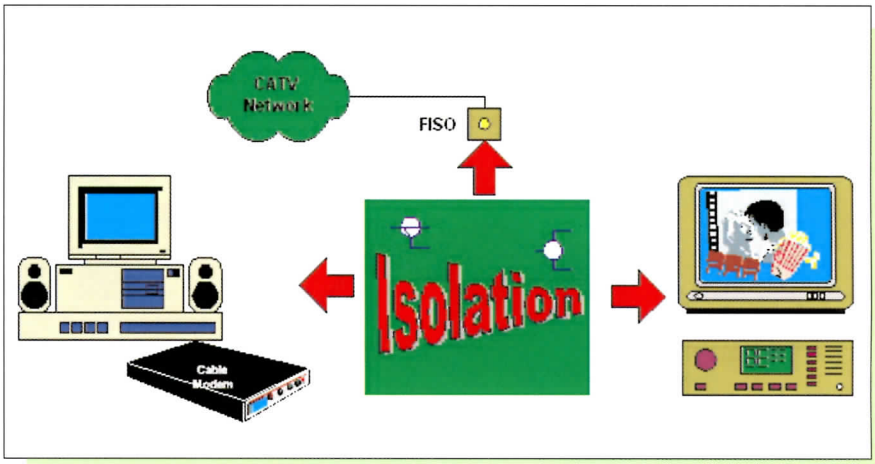

Figure 6 : Isolation of home installation from network

Mutual interference of connected equipment.

With the connection of return path equipment at the subscriber, we come to the return path and distribution signals being present on one cable or connection point. Besides frequency difference there is also level difference.

According to the CENELEC the requirements on the screening effectiveness of equipment is 75dB, and has a maximum value of radiation of 20dBpW. In a 75 Ohm impedance, the latter equals 39 dBμV. When we combine the two values we can determine a maximum output level for the return path modem of 114dBμV. In many instances these levels are also necessary to overcome the return path losses in the network.

The TV / VCR tuner is designed for maximum signal levels of 80 to 85 dBμV in the frequency range of 47 MHz to 862 MHz. Higher input levels bring about intermodulation problems. Signals below 47 MHz introduced into the antenna input of the TV / VCR can also cause intermodulation problems in the tuner.

In a EuroCableLabs/ Casema investigation it was established that signals in the frequency range of 5 to 30 MHz applied to the antenna input of a TV at high levels definitely caused interference. See *Figure 5*.

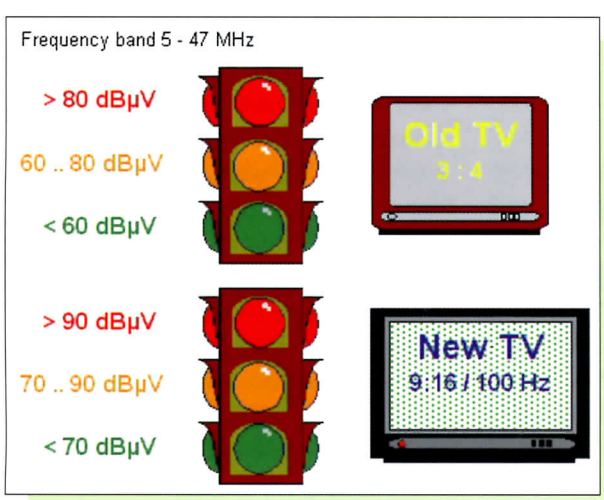

Figure 5 : Maximum spurious interference at TV antenna input

Effects on the TV/VCR

If we connect, without precautions, a cable modem via a splitter to the home installation, the modem signals are also present at the antenna input of the TV/VCR. Accepting that the output level of the cable modem is above 110dBμV there is a good chance that intermodulation interference will occur in the TV/VCR, caused by the cable modem.

In addition, the connection of more interactive services by the same subscriber whereby two or more cable modems are brought into use, can cause interference between modems to appear. For instance, an Internet modem can interfere with a Pay-TV decoder or a cable modem for telephony. See *Figure 6*.

This raises questions about the connections between equipment in such a way that they do not interfere with each other. The first question we must ask is how much isolation is necessary. It is a fact that cable modems are more robust than consumer electronics equipment. Therefore we can concentrate on the value laid down for television sets. The lower limit for a modern TV is 70dBμV, so with a level of 114dBμV from the modem, an isolation of 44 dB is necessary.

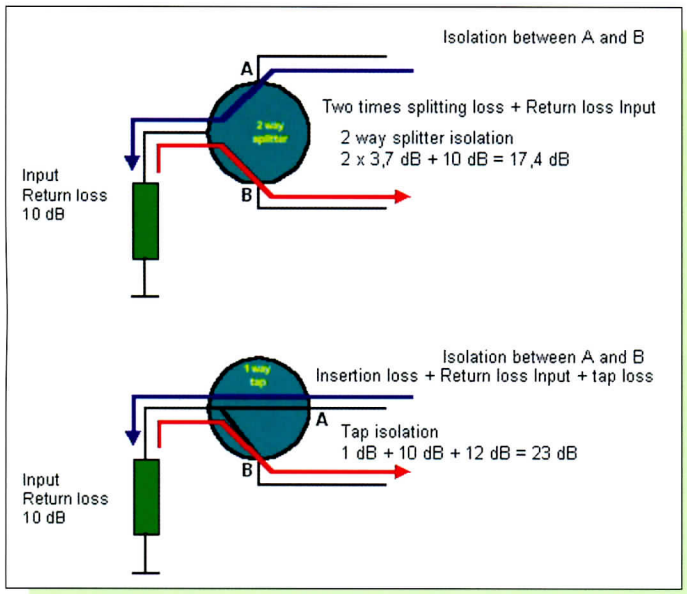

Figure 7 : Component isolation

Another starting-point is the CENELEC requirement. The supposition is that the minimum isolation between two subscribers on a cable network must be 40dB within the frequency band of 47 to 862 MHz. No value of isolation for the return path has been published.

The tap to tap isolation between two subscribers in the existing system amounts to not more than 40dB for the return path frequencies. The requirement for a higher isolation value in home installations, of the order of 40 dB to 45 dB seems impractical. From an economical viewpoint 40dB is a good value. Connection equipment for the home installation must also have a low price and filters with a 60dB loss are more complex than those with a 40dB loss.

Commonly used solutions

In a large number of cases, people have used standard components, like a splitter or tap, in order to connect a cable modem into a home installation. The manufacturer often finally specifies an isolation of 26dB or more on a two-way splitter. The isolation between output ports of a splitter is only directly dependent on the return loss at the input. When used in a home installation, where the splitter is connected to a system outlet, the return loss often is no more than 8 to 10dB. Therefore the isolation between the output ports is, in practice, no higher than twice the through loss (3.7dB) plus the return loss at the input (10dB), which equals 17.4dB. The same is true for a tap. Here also the isolation between tap and outlet is directly dependent upon the return loss at the tap input. See *Figure 7*.

With a tap, the isolation could well be higher but these also have the disadvantage that the return path and the distribution signals losses to the modem are too high.

Modem threshold

With many modems, the receive threshold is between 43 and 45 dBμV. A commonly used modem level downstream is –10dB with respect to the TV levels. For a connection with a minimum signal level of 60dBμV at the system outlet socket, a level of 50dBμV or more is available for the modem. This is 5dB above the threshold.

In practice, the subscriber may well use an amplifier to make a second connection. This can also be used to amplify the downstream modem signals, so further units can work with passive connections.

CONCLUSION

In a good home installation, we use fully isolated system outlets that are earthed on the subscriber side. By so doing we create a safe arrangement and prevent balancing and leakage currents.

The biggest problems with ingress are connecting cables and poor, or poorly installed connectors. In the home installation good connections can hold back this puzzling interference and ensure that it does not reach the return path of the cable network. After this, care must be taken in the connection of return path equipment with regard to the isolation between connected modems and the TV/VCRs.

Tratec Solutions

Tratec have a number of solutions for these problems. The AOP and TRAS-10 & TRAS-11 system outlets are well-known.

TRIS Product Line: This line contains a wide range of fully isolated system outlets. Here you will find models for Broadband, Radio and TV outlets, with or without return path data combiners.

For connecting cable modems to the home installation, there are also several advanced solutions. The widely known solution is in high mutual isolation between equipment connections. This applies to TV to TV, modem to modem and TV to modem connections.

Effective measures against interference radiation pickup keep the problem in the home and prevent ingress into the return path.

The return path input coupling loss for all passive models is under 1dB. The MSB series is new. The Multi Service Box offers three broadband connections for radio and TV, and three interactive connections for modems. For telephony there is a special model in the MSB line that is fitted with a lifeline function. It means that with power breakdown, the connection of the cable modem to the cable network is guaranteed.

Figure 8 is an example of a home installation using the MSB-01.

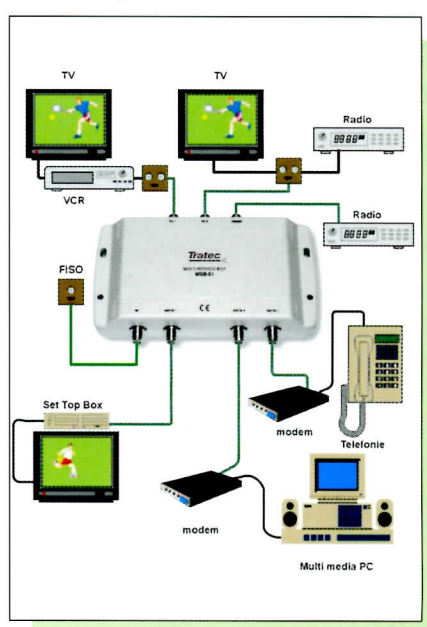

Figure 8 : Home installation using MSB-01

Gerrit Boskaljon

Gerrit Boskaljon is responsible for technical support to the International Sales Department of Tratec and for Special Products. After qualifying as an electronics engineer, he worked in radio frequency circuit design before joining Tratec in 1982.

Tratec
CATV Engineering & Components

Tratec Telecom BV
De Smalle Zijde 10
3903 LP Veenendaal
The Netherlands
Tel: +31 318 521 984
Fax: +31 318 529 104
e-mail customer-servicesAtratec.nl